IODINE DEFICIENCY IN DRINKING WATER AND ITS EFFECTS ON HUMAN HEALTH

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**Key words**: IDD (Iodine Deficiency Disorders), iodine deficiency, substitution prophylaxis, biomarkers

**Résumé.** Par l’investigation à l’aide des mécanismes etiopathologiques – la déficience iodine – IDD (DID) représentent un problème (un souci) de santé publique qui peut être prévenue une fois avec l’iodisation de la sel. Les objectifs de cet article consiste dans :1. la compréhension de la prévalence IDD dans les différentes territoires de la Moldavie, en concordance avec les concentrations iodines dans l’eau potable ; 2. la compréhension des quantités de iode dans la consommation du sel par la population ; 3. l’évaluation des possibilités d’utilisation pour bio marker les éliminations de l’urine iodine dans la maîtrise de la déficience des ressources dans le cadre du programme national de santé.

**INTRODUCTION. PURPOSE OF THE STUDY**

The statistics on IDD – national or WHO – are abundant in figures and details; these prove that by frequency, distribution, tendency, gravity and implications, IDD (Iodine Deficiency Disorders), represents a public health problem (12, 13).

IDD is part of the deficiency diseases/syndromes, existing since ancient times, and with different tendencies in different territories of the planet, and it is – with rare exceptions – a disease of underdevelopment, lack of culture, poverty in general (10).

For all these deficiency syndromes, the general etiopathological mechanism is the same: **the deficiency**, and the prevention/solving is simple and the same all the time: **compensation** is what is missing. (3)

IDD is the affection in which the etiopathogenic with iodine deficiency – in water especially – are unanimously admitted (7, 8, 9) and, as a result, the following appreciation of the WHO appears perfectly justified “…. *It is difficult to understand and impossible to admit, that iodine deficiency, the most frequent and preventable cause of mental deficiency in the world, is so highly spread in Europe*”(2).
Through the efforts of the governments, WHO, UNICEF, financial resources have been used for programmes for preventing IDD and, at the end of 1995, in 19 countries (of the total 83 in which there are data and studies) iodization of salt, as a collective prevention means, is realized in proportion of over 90%, in 15 countries - 75%, and in the other 49 countries the is already an infrastructure to produce iodine salt.(5).

In this general situation, Romania is situated with prevalence of IDD that creates a spreading of the endemic on approximately 2/3 of the territory of the country and with a national prevention programme, with individual and collective prophylaxis actions that date back 3 decades ago.

In this context, the research team from the Institute of Public Health in Iasi, the Section of Environment and medical staff has undergone a study in order to know the prevalence∗ of IDD in different territories of the country, on the basis of the morbidity∗∗ data presented currently by means of county/national system of information collected by the Ministry of Health and in relationship with the iodine concentrations in drinking water (11).

As a consequence, without obeying the rigours of a scientific research project, the present paper presents:

• Prevalence data – more or less complete – of the morbidity through IDD in different territories, by means of an epidemiological descriptive transversal investigation, on the basis of the county information that we had access to (11);

• Data on iodine level in the drinking water in the rural areas of Moldavia, found out by the common activities of our staff and of the county sanitary authorities (11);

• Data on the iodine concentration in the salt, as a result of the actions for the iodization of the salt and obtained by the annual monitoring of the Moldavian territory (5);

• Results of special investigations in order to propose the use of the urine iodine level, as a biomarker of human exposure to the iodine in the environment (water, food) (5),

RESULTS AND DISCUSSIONS

2.1 Prevalence of IDD in Moldavia – data on collective morbidity

∗ prevalence = form of expression of the morbidity, representing the total number of cases existing in the population at a certain moment; it is reported to each 100 or 1000 inhabitants

∗∗ morbidity = general term including the total phenomena when the human health deteriorates and there are several ways to express it (incidence, prevalence, etc)
For the territory of Moldavia, representing about 19.4% of the territory of Romania and 21.37% of the population of the country, we have a better knowledge of the public health problems in relationship with the quality of the environment, due to the methodological survey of the Institute on the 8 counties.

This previous knowledge allowed us to make the hypothesis according to which in the sub Carpathian counties (figure 1) iodine deficiency in water is greater and, as a result, the prevalence of IDD is great also.

In order to verify this hypothesis, we have used the data offered by the health and environment Geographical Information System regarding human and environment health for a previous accessible period of time.

We will present such data for several counties of Moldavia, considering the common aspects as well as the peculiarities that confer value, or, on the contrary, prove the limits of the existent information.

For Vrancea County, the information on the iodine content of drinking water (figure 2) and those referring to the prevalence of IDD (figure 3) are presented at the level of each communal territory, and therefore, the two cartograms show the superposing of the territories with IDD prevalence of over 10%/oo with those with iodine deficiency in water of under 3,5µg/liter (Tulnici – Soveja area).
Figure 2. Concentrations of iodine (µg/litre) in water sources from rural areas in Vrancea County
In Neamț County, the actions for investigating the level of iodine in water show territories with deficiency under 3 µg/litre (figure 4).
The prevalence of IDD is presented for the methodological zones of several territorial hospitals (Piatra Neamț, Tg.Neamt, Roman, Bicaz), as an average value for these zones, and because of this, some high morbidity values could be faded away in certain territories. Nevertheless, the area of Farcașa, Hangu, Ceahlău, Tarcău, Bicazu Ardelean and Bicaz Chei is clearly registering iodine efficiency in water and IDD prevalence of over 6% (figure 5).

In Suceava County we have retrospective data on the level of iodine in water, and the data on the prevalence of IDD are also aggregated on methodological zones belonging to the hospitals of Suceava, Rădăuți, Fălticeni, Gura Humorului, Vatra Dornei, Câmpulung Moldovenesc. As compared to the average annual prevalence of 20.11 % in the period 1980-1996, the area of Câmpulung has values which are 3 times higher (over 50 %) (figure 6)
Figure 6. Annual average rate of IDD prevalence in Suceava County in the period 1980-1996 (per 1000 inhabitants)

A synthesis of the existent data for the 8 counties show higher values in the sub Carpathian counties, which confirms the hypothesis of this study (tab. 1).

Table 1. IDD prevalence in the counties of Moldavia (cases per 1000 inhabitants) in different periods of time

<table>
<thead>
<tr>
<th>Sub – Carpathian Territories (N → S)</th>
<th>County</th>
<th>&lt; 15 years</th>
<th>15 years +</th>
<th>Average annual rate of prevalence (0-100 years) and the period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Suceava</td>
<td>63.01</td>
<td>4.91</td>
<td>20.11 (1980 – 1996)</td>
</tr>
<tr>
<td></td>
<td>Bacău</td>
<td>0.25</td>
<td>2.34</td>
<td>1.92 (1988 – 1996)</td>
</tr>
</tbody>
</table>
Iodine deficiency in drinking water and its effects on human health


No data

Eastern zone of Moldavia (N → S)

Botoşani 1.77 0.35 0.69 (1987 – 1997)

Iaşi - incomplete, inaccessible data -

Vaslui 1.39 1.66 0.59 (1990 – 1997)

Galaţi No data 0.17 (1987 – 1997)

Source: Statistics Services of the County Authority for Public Health

2.2 IDD prevalence at the medical investigation of the students health

Among the actions with preventive character of the medical services we can mention the annual evaluation of children and teenagers health at critical ages: 1st grade, 4th grade, 8th grade, 12th grade. On such an occasion, the prevalence of certain chronic diseases, including IDD can be found out. Here are the data for 2000 for the territory of Moldavia and Transylvania (for comparison) – with data from 12 counties belonging to the Institute of Public Health Cluj (table 2).

Table 2. The level of IDD prevalence for children and teenagers at the annual medical investigation in 2000 in Moldavia and Transylvania (cases per 1000 examined persons)*

<table>
<thead>
<tr>
<th>Examined group</th>
<th>Moldavia</th>
<th>Transylvania</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moldavia</td>
<td>6.58</td>
<td>2.84</td>
</tr>
<tr>
<td>urban</td>
<td>4.83</td>
<td>2.70</td>
</tr>
<tr>
<td>rural</td>
<td>10.72</td>
<td>3.16</td>
</tr>
</tbody>
</table>
4th grade  4.53
8th grade  7.15
12th grade  10.39

Suceava County  26.07  (1st place)
Vrancea County  12.83  (3rd place)

Neamţ County  8.54  (6th place)

*) Source: Annual synthesis of the results of the medical exams, IPH Iaşi and Cluj

We can notice the higher value of the prevalence for the counties in Moldavia (in the rural areas 3 times greater) than the territory of Transylvania, higher in the rural areas, and increasing with age and with levels over the average of Modavia in the counties of Suceava, Vrancea, Neamţ in which IDD occupies 1st to 6th places in the picture of the morbidity at these ages.

2.3 Concentrations of iodine in drinking water

Actions of smaller or greater importance were done in the previous years in order to evaluate the iodine content in the drinking water in the rural areas.

In Neamţ county, the investigations were done in two stages: 1981-1983 and 1997-1998, and they showed that over 60% of the samples presented iodine deficiency and ¼ of them had a severe deficiency (figure 7).
2.4 Iodine content in the salt

The most accessible method for the collective prophylaxis of IDD is the iodization of the salt (25 mg potassium iodate/kg until 1996, 45-50 mg/kg from 1996 until). Since 1980, the research team from the Institute of Human Health have studied the quantity of iodine in the salt, its stability in time or in the case of using different iodization methods (1) and the preoccupations continue by annual monitoring of iodine concentrations in the salt, in cooperation with the county sanitary authorities. This monitoring included the period 1989-2001, 5919 salt samples taken from different localities of Moldavia, and of all these samples between 30-60%, with tendency of increase in time, were inappropriate in respect of their content of iodate.(figure 8).

![Figure 8. Frequency of the inappropriate salt samples in Moldavia in the period 1989-2001](image)

In Suceava County and especially in Bacău county (counties in which the salt used by people comes from the salt mines of Cacica and Tg.Ocna) there is a more favourable situation (figure 9).
Figure 9. Frequency of the salt samples with appropriate iodine content in different counties

The quantity of iodine in the salt almost reached the recommended value (45-50 mg/kg) in Bacău and Suceava Counties (figure 10).

Figure 10. Average quantity of iodine in the salt samples taken in the Moldavian Counties (mg/kg)

### 2.5 Iodine in urine – a biomarker of human body exposure to the iodine deficiency in the environment

Since 1996, our preoccupations have been directed to the evaluation of the iodine eliminations in the urine, considering the quantity of 5 µg/l as a criteria for the diagnosis of iodine deficiency (4).

The results confirmed the presence and the different dimensions of deficiency for different groups of investigated people (we mention that these groups were not selected by using established criteria (6), as they were groups of
people included in other studies; at the same time, the small number of subjects in some groups makes the percentage processing of the results incorrect) (table 3).

Table 3. Distribution of investigated subjects according to the level of iodine in urine (per 100 of total samples)

<table>
<thead>
<tr>
<th>Investigated group</th>
<th>Number of subjects</th>
<th>Quantity of iodine in urine (µg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>+10 (normal)</td>
</tr>
<tr>
<td>Teenagers 14-16 years</td>
<td>79</td>
<td>45,57</td>
</tr>
<tr>
<td>Teenagers 16-18 years</td>
<td>182</td>
<td>0,76</td>
</tr>
<tr>
<td>Adults</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>Old people</td>
<td>25</td>
<td>12,0</td>
</tr>
</tbody>
</table>

The average values of the iodine in urine were low in general, usually below 5µg/l, and this proved that people are exposed to reduced iodine concentrations in drinking water – the main source of iodine for the human body (table 4).

Table 4. Average values of iodine in urine (µg/l) for different groups of investigated people

<table>
<thead>
<tr>
<th>Examined groups</th>
<th>Number samples</th>
<th>Average ± σ</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls, spring</td>
<td>30</td>
<td>3,59 ± 0,72</td>
<td>2,10</td>
<td>4,70</td>
</tr>
<tr>
<td>Boys, spring</td>
<td>11</td>
<td>3,86 ± 0,81</td>
<td>2,10</td>
<td>4,70</td>
</tr>
<tr>
<td>Girls, autumn</td>
<td>38</td>
<td>15,10 ± 4,30</td>
<td>8,40</td>
<td>22,30</td>
</tr>
<tr>
<td>Girls, Sanitary High</td>
<td>94</td>
<td>5,36 ± 1,32</td>
<td>1,71</td>
<td>11,87</td>
</tr>
</tbody>
</table>
CONCLUSIONS

1. The use of GIS for the knowledge of the morbidity through IDD has offered data of different complexity on different territories: separated for each locality, aggregated in sub-zones of a county or aggregated even in a unique value (irrespective of age, residence place: urban/rural) for the whole territory of the county, which creates difficulties in the territorial or chronological comparative evaluations.

2. The knowledge of the quantity of iodine in drinking water requires scientific investigation, using a representative number of samples, especially in the rural areas.

3. With all the limits of the value of the information data, the territories with high risk are pointed out, and the continuation and updating of the investigations require financial support within national programmes on health in relationship with environmental quality.

4. Monitoring of iodine content in the salt maintains its opportunity, iodation of the salt representing the method of collective prophylaxis of IDD that is easy to do, apply and control.

5. The determination of the quantity of iodine in urine meets the criteria of a test screening (simple method, acceptable for the population, with affordable cost in community) for the diagnosis of the iodine deficiency for population.

Bibliography


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